Lab: AP Review Sheets
Mechanics Chapter 15: Oscillation
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Background / Summary

Oscillation is a way that we can describe the x or y components of an object's linear position in terms of rotational variables. As long as the object returns to a certain y position, or x position, on a predictable interval, oscillation is the proper way to describe that motion.

Relevant Formulas (courtesy of the AP Equations sheet)

$$\vec{F}_s = -k\Delta\vec{x} \qquad x = x_{max}\cos(\omega t + \phi) \qquad T_s = 2\pi\sqrt{\frac{m}{k}}$$

$$U_s = \frac{1}{2}k(\Delta x)^2 \qquad T = \frac{2\pi}{\omega} = \frac{1}{f} \qquad T_p = 2\pi\sqrt{\frac{\ell}{g}}$$

Other Key Points

- In the above formulas, T is the period, Φ is the phase constant (a constant additive to your angular measurements), and ω is the angular speed, in this context the angular frequency.
- There are two types of oscillations: Periodic Motion and Simple Harmonic Motion
- Simple Harmonic Motion is just a more specific type of oscillation, and can be described by taking the simple equation for a particle's position $x = A\cos(\omega t + \phi)$ and deriving the equations for its velocity and acceleration from there:

$$v = -\omega A\sin(\omega t + \phi)$$

$$a = -\omega^2 A\cos(\omega t + \phi)$$

Review Problems

1. [Easy] If your heart rate is 150 beats per minute during strenuous exercise, what is the time per beat in units of seconds? (Textbook 15.23)
2. [Medium] Some people think a pendulum with a period of 1.00 s can be driven with "mental energy" or psycho kinetically, because its period is the same as an average heartbeat. True or not, what is the length of such a pendulum? (Textbook 15.43)
3. [Hard] Suppose a diving board with no one on it bounces up and down in a Simple Harmonic Motion with a frequency of 4.00 Hz. The board has an effective mass of 10.0 kg. What is the frequency of the SHM of a 75.0-kg diver on the board? (Textbook 15.58)

#1

$$\frac{150\,bt}{1\,min} \times \frac{1\,min}{60\,s} = 2.5$$

$$\frac{2.5\,bt}{1\,sec} = \boxed{0.4\,bt/sec}$$

#2

$$T_s = 2\pi\sqrt{\frac{l}{g}}$$

$$\left(\frac{T}{2\pi}\right)^2 g = l = \left(\frac{1}{2\pi}\right)^2 (9.8) = \boxed{24.2\,m}$$

#3

$$T = \frac{1}{f} = 2\pi\sqrt{\frac{m}{k}}$$

$$\frac{1}{4} = 2\pi\sqrt{\frac{10}{k}}$$

$$k = 6310$$

$$\frac{1}{f} = 2\pi\sqrt{\frac{85}{6310}}$$

$$= 0.729$$

$$\boxed{f = 1.37\ \text{Hz}}$$